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EXAMINER

SODERQUIST, ARLEN

ART UNIT	PAPER NUMBER
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1743

DATE MAILED: 01/25/2005

Please find below and/or attached an Office communication concerning this application or proceeding.

Office Action Summary

Application No.

09/409,644

Applicant(s)

LEWIS ET AL.

Examiner

Arlen Soderquist

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-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

- 1) ☒ Responsive to communication(s) filed on 05 November 2004.
- 2a) ☐ This action is **FINAL**. 2b) ☒ This action is non-final.
- 3) ☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

- 4) ☒ Claim(s) 50-72, 85-90, 98-110, 112-123 and 126-159 is/are pending in the application.
- 4a) Of the above claim(s) 50-72 and 85-90 is/are withdrawn from consideration.
- 5) ☐ Claim(s) _____ is/are allowed.
- 6) ☒ Claim(s) 98-110, 112-123 and 126-159 is/are rejected.
- 7) ☐ Claim(s) _____ is/are objected to.
- 8) ☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

- 9) ☐ The specification is objected to by the Examiner.
- 10) ☐ The drawing(s) filed on _____ is/are: a) ☐ accepted or b) ☐ objected to by the Examiner.
Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).
Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).
- 11) ☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

- 12) ☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).
- a) ☐ All b) ☐ Some * c) ☐ None of:
- ☐ Certified copies of the priority documents have been received.
 - ☐ Certified copies of the priority documents have been received in Application No. _____.
 - ☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

- | | |
|--|---|
| 1) <input checked="" type="checkbox"/> Notice of References Cited (PTO-892) | 4) <input type="checkbox"/> Interview Summary (PTO-413)
Paper No(s)/Mail Date. _____ |
| 2) <input type="checkbox"/> Notice of Draftsperson's Patent Drawing Review (PTO-948) | 5) <input type="checkbox"/> Notice of Informal Patent Application (PTO-152) |
| 3) <input type="checkbox"/> Information Disclosure Statement(s) (PTO-1449 or PTO/SB/08)
Paper No(s)/Mail Date _____ | 6) <input type="checkbox"/> Other: _____ |

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1. In view of the Appeal Brief filed on November 5, 2004, PROSECUTION IS HEREBY REOPENED. New grounds of rejection are set forth below.

To avoid abandonment of the application, appellant must exercise one of the following two options:

(1) file a reply under 37 CFR 1.111 (if this Office action is non-final) or a reply under 37 CFR 1.113 (if this Office action is final); or,

(2) initiate a new appeal by filing a notice of appeal under 37 CFR 41.31. A new notice of appeal fee and appeal brief fee will not be required for applicant to appeal from the new Office action. Any appeal brief filed on or after September 13, 2004 must comply with 37 CFR 41.37.

2. Claim 158 is rejected under 35 U.S.C. 112, second paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject matter which applicant regards as the invention. It is not clear if the carbon black-polymer composite is an insulating polymer or a conducting polymer. For examination purposes, it will be treated by examiner as an insulating polymer-carbon black composite.

3. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

(a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negated by the manner in which the invention was made.

The factual inquiries set forth in *Graham v. John Deere Co.*, 383 U.S. 1, 148 USPQ 459 (1966), that are applied for establishing a background for determining obviousness under 35 U.S.C. 103(a) are summarized as follows:

1. Determining the scope and contents of the prior art.
2. Ascertaining the differences between the prior art and the claims at issue.

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3. Resolving the level of ordinary skill in the pertinent art.
 4. Considering objective evidence present in the application indicating obviousness or nonobviousness.
4. Claims 98-110, 112-113, 115, 117-123, 126-135, 137, 139-157 and 159 are rejected under 35 U.S.C. 103(as a) as a being unpatentable over Gibson in view of Barisci (Trends in Polymer Science, 1996) and Casella, Thackeray, Yamato, Naarmann (DE 3,728,452), Li (Materials Research Society Symposium Proceedings, 1995), Sakaguchi (JP 4-2958), Stetter (US 5,512,882) or Wampler. In the patent application Gibson teaches an odor sensor. Page 1 teaches that sensors are important for a variety of applications including food freshness, headspace analysis and detection and quantification of bacteria. The page also teaches that the a personnel recognition sensor described includes a multiplicity of differentially responding chemo-resistor elements (a plurality or an array of sensors); a detector responsive to signals provided by the multiplicity of elements and arranged to provide an output signal characteristic of the multiplicity of signals; and a housing with the elements disposed therein having an inlet arranged so that a gaseous sample passing into or through the inlet contacts all of the elements in use (see each of the independent claims). Each element has a non-conductive substrate, a plurality of electrodes disposed on the substrate and one or more layers of a conductive polymer overlaying the electrodes, with the conductive polymers of at least two of the elements being different. The page also teaches that the sensors have been prepared on interdigitated gold electrodes (page 5) by polymerizing a number of monomers using chemical or electrochemical techniques; the polymers produced are electrically conducting and have varying sensitivities to volatile odor compounds; and the interaction between an odor compound and a conducting polymer is detected by a change in the electronic characteristics particularly the **resistance, impedance, reactance or capacitance** (claims 115,134,137,157) of the polymer film, which may be indirectly measured using changes in the applied potential or current. Page 2 teaches that the sensor may also include a memory (claim 150) adapted to store a library of odor profiles characteristic of particular individuals and means for comparison of the odor profile constituted by the multiplicity of signals from the sensor elements with an odor profile contained in said library. Standard pattern recognition techniques or a neural network (claims 147,149,152-153) may be adapted to retain characteristic features of the multiplicity of signals for incorporation

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into the library. The paragraph bridging pages 2-3 teaches that the conductive polymers may be selected from the following group: perimidine, polybenzene, polyphenylenesulphide, polyacetylene, polyaniline, polyphenylenediamine, polypyrrole, polythiophene, polyindole, polyimidazole, polythiazole, polybithiophene, polyphthalocyanine, polytryptophan and copolymers thereof. The following paragraph on page 3 teaches that a wide range of dopants may be employed including: nitrate, perchlorate, chloride, bromide, fluoride, sulphate, dodecyl and other alkyl sulphates, sulphonate, alkyl sulphonate, aryl sulphonate, fluoroborate, borate, phosphate, carbonate, iodide, ferricyanide; ferrocyanide, alkyl carboxylic acids (octanoic acid, acetic acid, etc), chromate, thiosulphate, sulphite, silicates and vanadate. Page 6 teaches that chemical polymerization may be carried out using suitable oxidizing agents such as sodium persulphate, sodium periodate, ferric nitrate, ferric perchlorate and the like added to a solution of the monomer deposited onto the upper surface of the cleared transducer. The polymeric material is formed as an insoluble layer and the upper surface of the interdigitated area covers the whole active surface of the transducer. Page 6 also teaches that electrochemical polymerization may be achieved by incorporating the interdigitated transducer into an electrochemical circuit as the anode or cathode dependent on the polymer species to be formed. Anodic deposition, the most common technique, is carried out by immersion of the transducer in a monomer solution with a platinum counter-electrode adjacent the surface and a reference electrode (silver/silver chloride or calomel) connected into the circuit via a salt bridge. The system may then be either maintained at constant potential or alternatively the potential may be cycled between two predetermined values to allow formation of the polymer film on the transducer surface. Examples on pages 11-13 illustrate the electrochemical polymerization process for poly-1,4-phenylenediamine, polyimidazole, polyquinoline, poly-N-phenyl-1,4-phenylenediamine, and a co-polymer of pyrrole and 1-methylpyrrole. The first full paragraph of page 13 teaches that polymers prepared using similar techniques include: polypyrroles, polythiophenes, polyindoles, polyphthalocyanines, polyanilines, polycarbazoles, polythionine, polyaminonaphthalenes, polyaminoanthracenes, polyphenylenediamines, polyaminiophenols, polynaphthyl(ethylenediamine), polyimidazoles, polyquinolines, polytryptophan, polyhetero cycles, polyaminohetero cycles and substituted derivatives of the above compounds. The same paragraph also teaches that **copolymers and blends of the above compounds may be**

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employed. The listed polymers may be treated with various ionic dopant molecules, as outlined above, incorporated into the conducting films during and post polymerization. The last full paragraph of page 13 teaches that the array includes between 3 to several hundred sensors. Multiple arrays may incorporate 16 and 32 sensors and may be arranged to operate from either a constant current or constant voltage power supply. The sensor array may be disposed in the housing adapted to allow flow of a gaseous sample over each of the sensor elements. A gaseous sample may be simply injected into the space above the array. Alternatively a piston, bellows or other pump arrangement may be employed. Figure 1 and its description on pages 14-15 present the response of a 16 sensor array to two samples of odor from a subject collected in a syringe and blown across the array. The sensor elements that make up the array include the following polymers and dopants: 1) poly-n-ethylaniline with SO₄ counter ion; 2-3) poly-aniline with SO₄ counter ion; 4-5) poly-tryptophan with SO₄ counter ion; 6) poly-2-methoxy-5- nitroaniline with SO₄ counter ion; 7) thiophene/thiophene-3- carboxylic acid copolymer with tetrabutyl-ammonium perchlorate counter ion; 8) poly-aniline with ethanol and with SO₄ counter ion; 9) poly-pyrrole with octanoic acid ethyl ester dopant; 10) poly-pyrrole with an upper layer of poly-tryptophan with octanoic acid ethyl ester dopant and with ClO₄ counter ion; 11-12) poly-1,4-phenylenediamine with Cl counter ion; 13) poly-pyrrole with Cl counter ion; 14) poly-pyrrole with tetrabutyl-ammonium perchlorate counter ion; 15) pyrrole/1-methyl pyrrole copolymer with NO₃ counter ion; and 16) poly-pyrrole with octanoic acid ethyl ester dopant. Figures 3-4 show alternative configurations of the interdigitated electrodes. Pages 3-4 describe a second array of sensors including a different set of polymers that is intended for food analysis and quality control identification of bacterial infection, prediction of oestrus in livestock and environmental monitoring (claim 148). Page 16 describes a system for measuring the response of a 16 sensor array to compounds using a setup to sample the headspace above a liquid sample. This system uses a personal computer and dedicated software to acquire and process the resistance data. Gibson does elaborate on what constitutes a blend of the polymer compounds listed on page 13 and how the blend is different from the copolymers listed in the same sentence. Gibson also does not teach blends or mixtures of the listed conductive polymers with inorganic conductors (metal particles, metal oxides, etc.), organic conductors (carbon black, charge transfer complexes, etc.) and mixed inorganic/organic conductors claimed in which the two conductive

materials are mixed together to form as a single sensing material having the compositionally different conductive material within the conductive organic material.

In the paper Barisci gives a review of conducting polymer sensors. The review examines recent advances in the application of electrically conducting polymers in sensing devices. Figures 1-2 and 4, reproduced below, show some representative conducting polymer and setups for different measurement methods which are found in the references applied against the claims. In 2(b) the working electrode is separated from the other two electrodes by the polymer layer so that in all instances the potential, current or resistance being measured is measured through the conducting polymer layer. The second paragraph of the article on page 307 teaches that the discovery of conductive electroactive polymers shown in figure 1 heralded a new era in electrochemical research because the materials are inherently conducting, an unusual property for a polymer. In the course of numerous studies it has become obvious that the electrical properties of these new materials are very dependent on their chemical composition and on the chemical environment to which they are exposed. This susceptibility to the chemical environment provides the basis for the use of these materials in new sensing technologies.

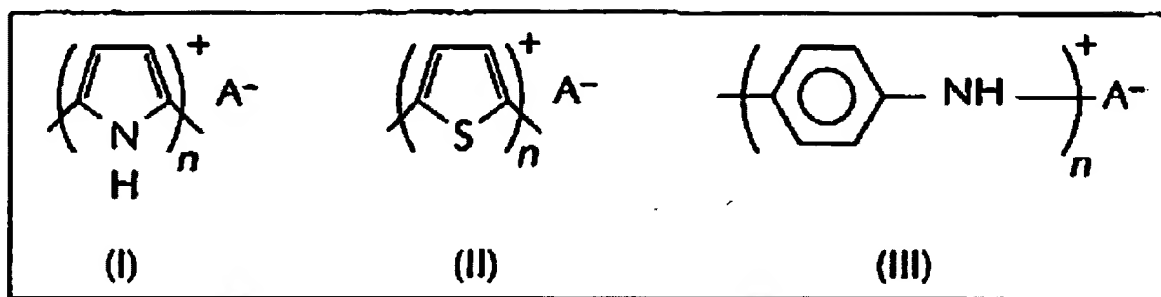


Fig. 1 Idealized structures of some common conducting electroactive polymers: polypyrroles (I), polythiophenes (II) and polyanilines (III) (A^- , counterion).

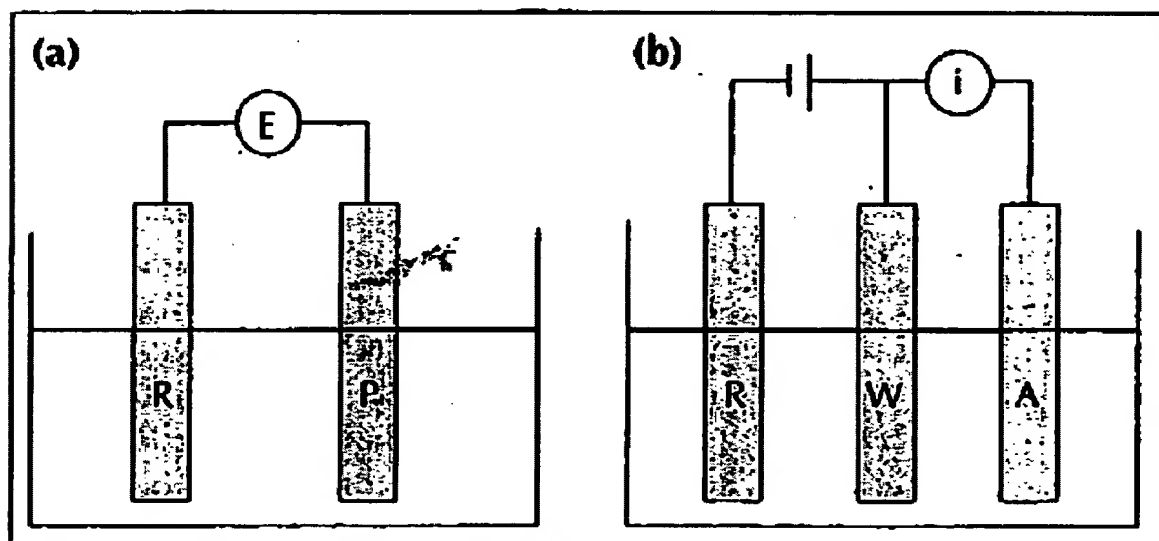


Fig. 2 (a) Setup for potentiometric measurement techniques: E , potential-measuring device; R , reference electrode; and P , polymer electrode. (b) Setup for current-measuring techniques: i , current-measuring device; A , auxiliary electrode; W , working electrode; and R , reference electrode.

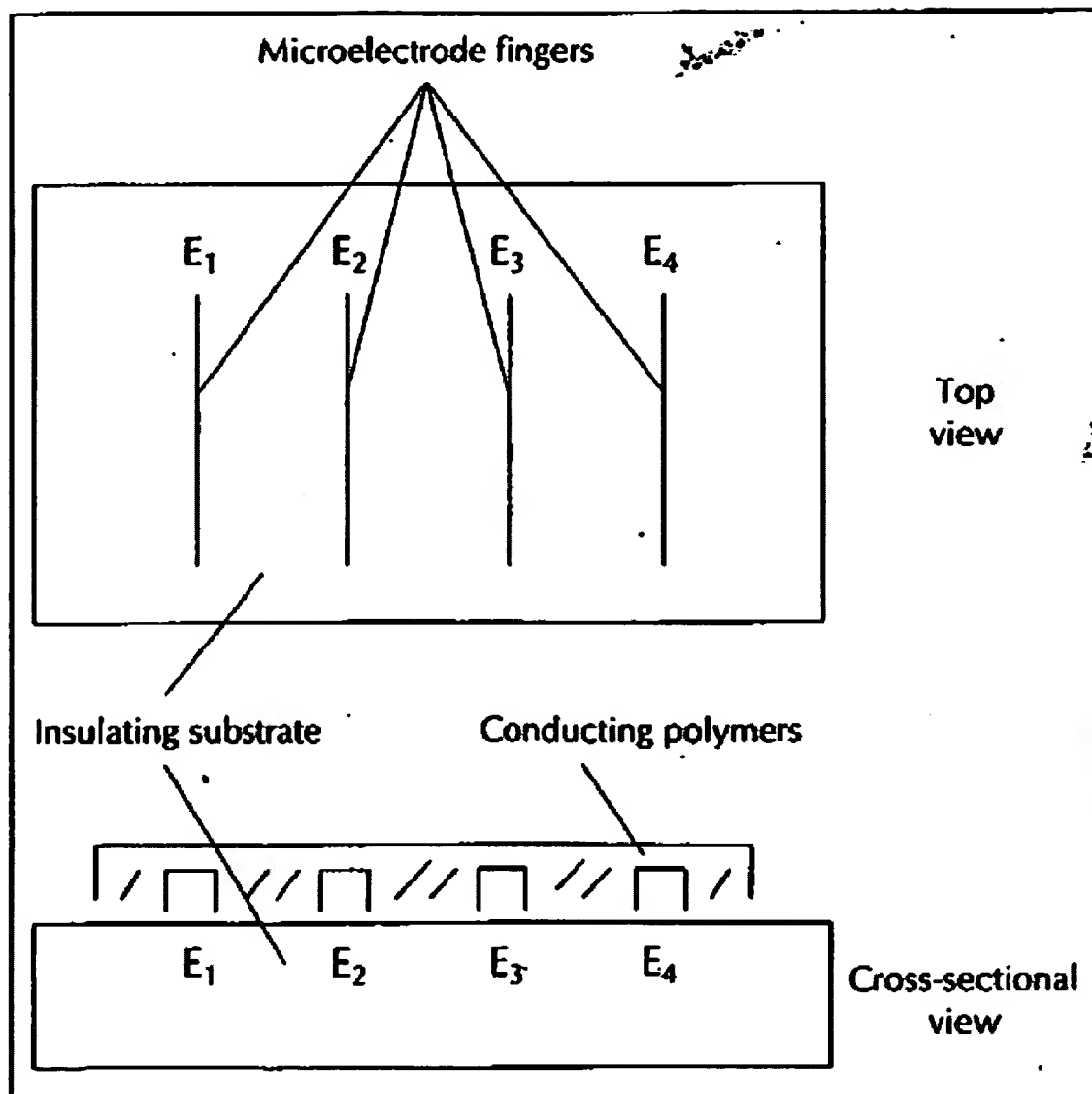


Fig. 4 Microelectrode array for resistance measurements. Current is passed between E_1 and E_4 , and the voltage drop between E_2 and E_3 is measured. This voltage is used to calculate the resistance.

Methods of signal generation, mainly electrical and electrochemical, are discussed, as are strategies for introducing into the polymer structure appropriate analyte recognition characteristics. The use of conducting polymers in gas sensors and in solution sensors for detection of chemical and biochemical species was reviewed with some conclusions. Relative to the methods of signal generation, page 307 teaches that the polymers can produce signal through

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potentiometric, current-measuring and conductometric/resistometric methods (see figures 2 and 4 above). The current-measuring methods (pages 307-308) are taught as including 3 or 4 ways that an analyte can interact with the conductive polymer (e.g. polypyrroles, polythiophenes and polyanilines) to modify the current flow as a function of the applied potential. Particularly relevant to the instant invention is the fact that the current measuring section points to the conductometric/resistometric section (page 308) for one way that the current flow can be modified through interaction of an analyte and the conducting polymer. Further it is clear from the discussion of both sections that the current flow can be affected by the interaction of the analyte with the polymer or its counter ion (see the second full paragraph of the right column of page 308). Thus there is a connection between the different signal generation methods that would have been recognized by one of skill in the art (changes that affect the current flow would have been expected to provide a signal in both the current measuring and conductometric/resistometric methods). In the solution sensor section, amperometric detection is discussed. Relevant to the instant claims is the second full paragraph of the section on page 308. This paragraph teaches that amperometric detection is based on the changes in current flow caused by oxidation/reduction of the polymer. This paragraph also teaches that the selectivity to a particular anion or anions is influenced by counter anion incorporated into the polymer. The response observed is due to the inclusion/expulsion of cations present in solution as the polymer is reduced or oxidized. The first full paragraph of page 309 discusses the use of overoxidized polypyrrole, known to be less conductive (more resistive), as analytical sensor with sufficient signal to function as a sensor. In the gas sensor section of the paper both electronic interactions with the polymer and swelling of the polymer by the analyte are discussed as the basis for the measurable changes in the current flow in the polymers. In the second full paragraph of the section on page 310, the gas sensing properties of polypyrrole are discussed with the sensitivity of the polymer to different gases (NO_2 and H_2S) being based on their oxidizing or reducing the polymer. **The signal results from the associated change in the resistance of the polymer.** This clearly shows a connection between the oxidation/reduction (redox) state of the polymers and the resistance level of the polymer and a corresponding expectation that changes causing signals with for a measurement method of the current measuring type **also causing a measurable change in the resistance of the polymer!** Page 310 also discusses the use of

different pattern recognition methods when arrays of the sensors are used (see right column). In the first paragraph of page 311, a discussion of composite materials in which the conducting polymer is combined with another material. These composite materials showed improved reproducibility when used as sensors which adequately compensated for any problems due to an expected lower sensitivity. The third and fourth paragraphs of the same page discuss the versatility of these conducting polymers and the fact that the molecular structure of these materials influences their electrical properties and enables their interaction with a wide variety of chemical species leading to useful applications in solution and vapor phase sensing.

In the paper Casella discusses copper dispersed into polyaniline films (represents the inorganic conductor/organic conducting polymer combination) as an amperometric sensor in alkaline solutions of amino acids and polyhydric compounds. As a chemically modified electrode composed of copper microparticles dispersed into a polyaniline (PANI) film was studied as an amperometric sensor of scanty electroactive compounds possessing -OH and -NH₂ groups. Glassy carbon was used as an electrode material and modified firstly by a PANI film, then allowed to stand in contact with a solution of copper ions, and finally, the electroreduction was done at -0.3V. Page 220 in the sentence which bridges the two columns teaches that about 12% of the deposited copper was dispersed (able to penetrate) in the polymer matrix. The electrochemical behavior of the resulting modified electrode in alkaline medium was examined by cyclic voltammetry and flow-injection amperometry. Using some representative compounds, the effect of copper loading and pH on the electrode response was studied. Constant-potential amperometric detection was applied in conjunction with anion-exchange chromatography (AEC) separations of amino acids and carbohydrates. At an applied potential of 0.55 V vs. Ag/AgCl, the detection limits (S/N = 3) for all analytes studied ranged 5-15 pmol, and the linear dynamic range was three-four orders of magnitude above the detection limits. The resulting modified electrode was found to retain 95% of its initial response in flowing streams for 3 hours of operating time. From the title at least it is clear that the copper particles are dispersed **into** the polyaniline films.

In the paper de Lacy Costello teaches composite organic-inorganic semiconductor sensors for the quantitative detection of target organic vapors. Composites of tin dioxide (an n-type semiconductor within the scope of claim 127) and derivative of the conducting polymer

polypyrrole (a p-type semiconductor) gave reversible changes in electrical resistance at room temperature when exposed to a range of organic vapors. The optimum amount of polymer giving highest sensitivity was found to be 2.5% by mass for the polypyrrole chloride-tin dioxide composite. Composites containing 2.5% polymer by mass, but differing in polymer derivative were fabricated and exposed to low concentrations of ethanol, methanol, acetone, methyl acetate and ethyl acetate. All gave significant and reversible decreases in electrical resistance. Direct comparison with sensors constructed solely of tin dioxide or polypyrrole at room temperature showed the composites to be more sensitive. The gas sensitivity of the composite materials depended on the type of polymer derivative incorporated and the dopant anion associated with the polymer. The composites were simple to fabricate and gave differing response profiles to a range of organic vapors.

In the paper Thackeray teaches chemically responsive microelectrochemical devices based on platinized poly(3-methylthiophene) (represents the inorganic conductor/organic conducting polymer combination) and shows variation in conductivity with variation in hydrogen, oxygen, or pH in aqueous solution. Microelectrochemical transistors can be prepared by connecting 2 closely spaced ($\sim 1.2 \mu\text{m}$) Au microelectrodes ($0.1 \mu\text{m}$ thick \times $2.4 \mu\text{m}$ wide \times $50 \mu\text{m}$ long) with anodically grown poly(3-methylthiophene). The amount of poly(3-methylthiophene) used involves about 10^{-7} - 10^{-6} mol of monomer/ cm^2 . Poly(3-methylthiophene) can be platinized by electrochemical reduction of PtCl_4^{2-} at the pair of coated electrodes. The change in conductivity of poly(3-methylthiophene) with change in redox potential is the basis for amplification of electrical or chemical signals; the conductivity varies by 5-6 orders of magnitude upon change in potential from +0.2 (insulating) to +0.7 (conducting) V vs. SCE in aqueous electrolyte. The Pt equilibrates poly(3-methylthiophene) with the $\text{O}_2/\text{H}_2\text{O}$ or $\text{H}_2\text{O}/\text{H}_2$ redox couples. [Poly(3-methylthiophene)/Pt]-based transistors are shown to be viable room-temperature sensors for O_2 and H_2 in aqueous solution. The O_2 reproducibly turns on the device, with 1 atmosphere of $\text{O}_2/0.1 \text{ M HClO}_4/\text{H}_2\text{O}$ showing 0.7-mA I_D at a $V_D = 0.2 \text{ V}$; H_2 reproducibly turns off the device, with 1 atmosphere of $\text{H}_2/0.1 \text{ M HClO}_4/\text{H}_2\text{O}$ showing less than 20-nA I_D at a $V_D = 0.2 \text{ V}$, where V_D (drain potential) is the applied potential between the 2 Au microelectrodes and I_D (drain current) is the current that passes between the 2 microelectrodes. The turn on with O_2 is complete within 2 minutes, and the turn off with H_2 is complete within 0.3 minutes. A

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platinized microelectrode of a dimension similar to the microelectrochemical transistor shows only 1.0-nA reduction current upon exposure to 1 atmosphere of O₂; the current amplification of the transistor is thus a factor greater than 10⁵. The transistor device can also reproducibly respond to pH changes in the pH range of 0-12, when there is a constant O₂ concentration; there is a reproducible change in I_D to alternate flow of a pH 5.5/pH 6.5 stream for over 10 h. The device responds to an injection of 10⁻⁶ L of 0.1 M HClO₄ into an effluent stream of 0.1 M NaClO₄ (flowing at 2 mL/min) within 4s. Study of the resistance properties of [poly(3-methylthiophene)/Pt] vs potential reveals that Pt has little effect on the intrinsic conductivity of poly(3-methylthiophene). Rather, the role of Pt is purely as a catalyst to allow equilibration of O₂ and H₂ with the polymer. The amount of Pt used is approximately 10⁻⁷ mol/cm², and microscopy shows Pt to be present as a particle of less than 0.1-μm size.

In the paper Yamato presents a new method for dispersing palladium microparticles in conducting polymer films (represents the inorganic conductor/organic conducting polymer combination) and its application to biosensors. Composite films of polypyrrole/sulfated poly(β-hydroxyethers) (PPy/S-PHE) are electrically conducting and mechanically flexible. Palladium particles were dispersed in the films by thermally decomposing bis(dibenzylideneacetone)palladium(0) complex which had been absorbed by the films from a CHCl₃ solution. This method for loading metal particles was enabled by the high affinity of the composite films for organic compounds. TEM and energy-dispersive x-ray spectrometry (EDX) analyses revealed that fine palladium particles in the nanometer range are dispersed in the PPy/S-PHE conducting films. a glucose sensor based on the detection of hydrogen peroxide was prepared by immobilizing glucose oxidase (GOD) using glutaraldehyde on a Pd/PPy/S-PHE electrode. This biosensor responded to glucose even at 400 mV vs. Ag/AgCl, which is lower than the working potential of conventional glucose sensors prepared on a platinum electrode.

In the published application Naarmann teaches manufacture and use of electrically conductive polymers of five-membered heterocyclic compounds and anions of tetrathiafulvalene derivatives (represents the organic conductor/organic conducting polymer combination). The polymers are prepared by electrochemical oxidative polymerization of 5-membered heterocyclic compound(s) in the presence of conducting salts containing anions of tetrathiafulvalene derivatives. The polymers are used as sensors or battery electrodes. Derivatives of

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tetrathiafulvalene were synthesized. a solution of 1 part pyrrole and 1 part NH_4 salt of 3,6-di-sulfobenzyloxy-1,2,4,5-benzo-bis(11,11',12,12'-dibenzotetrathiafulvalene) in 100 parts MeCN was electropolymerized by using Pt electrodes. The obtained polymer film had an electrical conductivity of 80 S/cm and showed a superior stability in a 1-week storage in water to a ClO_4^- -containing polypyrrole film.

In the paper Li teaches the preparation and characterization of polyaniline-palladium composite films (represents the inorganic conductor/organic conducting polymer combination). Electrosynthesized polyaniline (PANi) can be chemically functionalized by incorporation of palladium clusters. The functionalization of electrochemically, freshly prepared and dried PANi film occurs spontaneously during the relaxation process. This process is carried out in sulfuric acid containing palladium salt. The material properties of the new composite PANi-Pd film were investigated by applying electrochemical, UV-visible spectroscopic and surface microscopy techniques. The PANi-Pd composite materials behaved electrochemically different than PANi film alone or Pd film deposited electrochemically. This finding is particularly important for developing layers for chemical gas sensors, electrocatalysis or supercapacitors applications. Page 581 discusses the emeraldine (conducting) form of polyaniline

In the published application Sakaguchi teaches electrodes for gas sensors. The electrodes consist of a composite of a resin compound, a conductive resin compound, and optionally an organic metal complex compound. Preferably, a conductive resin compound is manufactured by chemical oxidation polymerization or electrolytic polymerization. The gas sensors are useful for detection of gas components in exhaust gases and combustion waste gases, and have long life. From the attached Chemical Abstracts abstract it is clear that at least polypyrrole is disclosed as a conductive resin polyvinyl chloride is disclosed (an insulator, see claim 101) and cobalt phthalocyanine are disclosed (represents the organic conductor/organic conducting polymer combination). The JPO abstract teaches iron or platinum complexes with phthalocyanine and naphthalocyanine also being used.

In the patent Stetter teaches a chemical sensing apparatus for the detection of a vapor of a selected chemical substance includes a sensor whose impedance changes upon exposure to such a vapor. The sensor comprises a polymer whose physical structure is altered by the vapor, e.g., through expansion or disintegration, and electrically conductive elements that are interspersed

with or separated by the polymer. The interspersed elements may consist of a fine powder of carbon or of a metal in a matrix of silicone or other vapor-sensitive polymer. The electrical contacts between the powder particles are weakened when the polymer swells or disintegrates, which results in increased resistance. Alternatively, the capacitance between two conductive layers separated by a polymer layer decreases, and hence the impedance increases, when the polymer swells upon exposure to the vapor. In the paragraph bridging columns 2-3 Stetter teaches that the particles are conductive and include carbon powder (carbon black), copper, silver, gold, platinum or other suitable metal. This patent shows alternative forms of inorganic conductors. The patent discusses how the conductivity can be affected by either the polymer swelling or being degraded due to the interaction of the analyte with the polymer.

In the paper Wampler discusses the chemical synthesis and characterization of composites of polypyrrole and carbon black. A new class of molecular composites of carbon black and an electronically conducting polypyrrole has been synthesized by chemically polymerizing pyrrole in an aqueous dispersion of carbon black. The carbon black content of these composites can be varied from ~5% to ~85% (by weight). The surface areas and densities of these composites were compared to corresponding mixtures of carbon black and polypyrrole. The influence of carbon black on the efficiency of polymerization of pyrrole is described. The effect of carbon black content on the electronic conductivity of the composite has been mapped, and compared with the corresponding behavior of a mixture of carbon black and poly(vinyl chloride). The influence of the parent black characteristics (porosity, void vol., surface area) on the electronic conductivity of the resultant composite has been probed by comparing the behavior of composites derived from six commercial and experimental blacks. The temperature dependence of the composites has been studied as a function of the carbon black content. The application of these new materials is examined. The first page of the paper teaches that the potential applications include sensors, electrocatalysis, super capacitors and fuel cells. In the sentence bridging pages 1811-1812 Wampler teaches that other similar composites of conducting polymers with polymers, metals, or metal oxides has extended the scope of their use. The paper clearly shows that the composite is superior to either component of the composite when applied to the electrocatalysis of chromium(VI) to chromium(III).

It would have been obvious to one of ordinary skill in the art at the time the invention was made to incorporate the teachings of Casella, de Lacy Costello, Thackeray, Yamato, Naarmann, Li, Sakaguchi, Stetter or Wampler relative to the incorporation of conductors such as carbon black, anions of tetrathiafulvalene derivatives, metal particles or metal oxide into the conductive organic polymers used in the sensing arrays of Gibson because of their sensitivity to known analyte gases or enhanced sensing and/or stability properties as taught by each of Casella, Thackeray, Yamato, Naarmann, Li, Sakaguchi or Wampler compared to sensors made with only the conductive polymers taught by Gibson and the recognized ability and expectation of the Gibson conductive polymers to be affected by interactions in a number of sensing formats in a manner that changes the electronic structure and as a result the resistivity of the polymer as shown by Barisci.

5. Claims 114, 116, 136, 138 and 158 are rejected under 35 U.S.C. 103(a) as being unpatentable over Gibson in view of Barisci and Casella, Thackeray, Yamato, Naarmann, Li, Sakaguchi, Stetter or Wampler as applied to claims 108, 113, 115, 128, 135, 137 or 152 above, and further in view of Breheret, Mifsud (both US 5,801,297 and WO 95/08113), Moy or Persaud (WO 86/01599). Gibson does not teach a temperature control apparatus in thermal communication with at least one sensor or a sensing array having sensors that are not organic polymer based.

In the paper Breheret presents online differentiation of mushrooms aromas by combined headspace/multi-odor gas sensors devices. a specially designed measurement cell for direct headspace analysis, online connected to (I) a gas chromatograph equipped with an headspace injector and a sniffing-port, (ii) multisensors devices: five semiconductor gas sensors and twenty conducting polymer gas sensors, was used to discriminate nine mushrooms' aromas. The raw data of gas sensors were statistically processed, and provided pictorial presentation under sample distribution in a plan, allowing to compare the different mushrooms' aromas, with the GC/sniffing analysis. Semiconductor gas sensors succeeded in classifying four groups based on overall odor. Semiconductor gas sensors seem to be more appropriate for the mushrooms aromas discrimination than conducting polymer gas sensors. These preliminary results confirm the interest of such technologies for chemotaxonomy differentiation of wild mushrooms. Page 104 in the discussion of semiconductor gas sensors teaches that a control unit providing a

constant potential to the sensor circuit voltage and a variable potential to the heater circuit is used (a temperature controller is used).

In the patent and patent application Mifsud teaches methods and devices for the detection of odorous substances and applications. A device for carrying out a method of odor detection including, in particular, a plurality of chambers, each having a plurality of semi-conductor gas sensors, conductive polymer gas sensors, surface acoustic wave gas sensors, as detection means, a variable flow gas pump for forming a gas flow in said chambers, measurement electronic device for operating the detection means, a data processing unit for recording in a file the olfactory prints obtained using the detection means, and for comparing the detected impressions with those in the file so that odors may be identified and recognized. Applications, especially to drugs, explosives, body odors and food seals. Column 1 of the patent discusses the various types of sensors available and notes that semiconductive gas sensors must operate at a high temperature, around 350° C. Column 6, line 62 to column 7, line 57 teach at least one temperature sensor and humidity sensor, are placed in at least one of the enclosures to measure the temperature and the humidity of the gas flow. The temperature and humidity level parameters influence the measurements of the piezo-electrical and/or electrical properties of the gas sensors. It is therefore necessary to know the values of these parameters to perform comparisons of the odorous substances. The set of gas sensors, temperature sensor and humidity sensor are connected to measurement electronics enabling the steps of testing and measuring the electrical and/or piezo-electrical properties of the gas sensors with or without odorous substances and measuring the temperature and humidity of the gas flow. The data is furnished by the choice of the sensitive parts equipping the sensors, notably the choice of polymer for the conductive-polymer sensors and the surface-acoustic-wave sensors based on the needs of the user of the apparatus. For the semiconductive sensors, the data is furnished by the choice of the type of metallic oxide as well as the choice of their respective operating temperatures, according to the needs of the user. The temperature can be regulated independently for each semiconductive sensor by the measurement electronics, during the stage of testing the electrical properties, in order to determine an optimal range of usage of the sensors.

In the paper Moy discusses transient signal modeling for fast odor classification. The Fox 2000 is an electronic nose system using an array of 6, 12, or 18 gas sensors. The analysis of

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sensor signals coming from a combination of metal oxide sensors and conducting polymer elements indicates the ability of predicting in only a few seconds the nature of a sample (hams, sausages, cereals...) from its olfactory fingerprint. The simulation of the signals is performed via exponential functions and applied to various foodstuffs. Online and real time Artificial Neural Network (ANN) have also been investigated for fast odor classification and recognition. Six different brands of sausages (pure pork, beef/pork sausages) have been analyzed using a 6-element array. Six samples of each type of sausage were measured 12 times and discriminant analysis was performed over the set of 72 samples using the raw data of acquisition. 94% of the samples were correctly classified and cross validation (testing unknown samples) gave an overall success rate of 83% correctly classified samples. These results indicate the possibility to use electronic noses and pattern recognition methods for fast odor classifications.

In the published application Persaud teaches gas sensors. A sensor for gases, vapors, or odors has an organic polymeric semiconductor element which changes its electrical resistance in the presence of certain gases. The polymer is formed by electrolytic deposition on the substrate from a solution of its monomer, the solution comprising a solvent medium in which the monomer is sparingly soluble, a protic solvent, and an ionic base. A number of different gas detectors can be used to obtain from each a characteristic response to the presence of a gas, and the combination of responses can be used to distinguish between gases. The different detectors may be all based upon organic polymers, or one or more detectors may use other principles such as flame ionization or gas chromatography. The sensor is useful in monitoring industrial environments, gas liquid chromatography, quality control in food and drinks production, and food production. Page 14, line 2-9 teach that the different types of sensors can allow the device to detect between odors that it might not otherwise be able to discriminate. Page 16, lines 15-21 teach that an alternative form of the sensor is as a polymer coated field effect transistor.

It would have been obvious to one of ordinary skill in the art at the time the invention was made to incorporate other types of sensors such as the metal oxide and/or surface acoustic wave devices taught by Breheret, Mifsud, Moy or Persaud into the Gibson device because of the ability to use them in combination to discriminate odors that would not easily be discriminated by a single type of sensor as taught by Breheret, Mifsud, Moy or Persaud or in the review of Barisci. It would have been obvious to one of ordinary skill in the art at the time the invention

was made to incorporate a temperature controller into the Gibson device because of the need for sensors such as the semiconductor sensors of Breheret and Mifsud to operate at an elevated temperature for sensitivity as taught by Breheret and Mifsud.

6. Applicant's arguments filed November 5, 2004 have been fully considered but they are not persuasive. First the single rejection has been reorganized into two separate rejections to separate the claims that are properly treated on a separate basis. Second the descriptions of the references have been modified to better point out the relevant teachings in each reference. In particular the description of the Barisci reference has been expanded to show the connection between the interaction of the analyte with the counter ions or polymer and an expected change in the resistivity of the polymeric material. Relative to the Barisci reference, applicant is advised that a reference can be used to show the knowledge or level of skill of one of ordinary skill in the art. This is one purpose of the reference. It also clearly shows the connection between the different signal producing methods with a date that is more than one year prior to the earliest priority for the instant application. Thus through the teachings in the Barisci reference the expectation of measurable resistivity changes in the conducting polymers by changes that are measurable by amperometric techniques are clearly shown. Additionally the figures submitted with the Appeal Brief are not an accurate representation of the different sensor types. First figure 1 appears to show the regions as regular stacked separate alternating regions rather than the random regions that exist unless applicant has used some technique to produce regular regions. The regions of figure 1 appear to have been produced by a method as found in the newly cited Iyoda reference. Second, the Barisci figure 2 is a more general depiction of the structure used to make the amperometric measurements. Examiner does not agree with applicant that the Barisci reference teaches away from the combination or modification of the Gibson type sensor by another type (amperometric) sensor using a different measuring technique. The real question is not what are the differences in the measuring technique, but what are the properties of the material that lead to the signal being measured and would one of ordinary skill in the art recognize and/or expect the interactions leading to measurable changes by one measurement technique also cause changes that are measurable by a second measuring technique. On this count the Barisci reference is fully supportive of the examiner's position! In the discussion of the different measuring techniques it is clear that changes in resistivity also lead to changes that

can be measured by a current measuring technique as in an amperometric sensor. In the other sections of the Barisci reference, the discussion is not again grouped along the lines of the type of measuring method and there are reference to changes in at least the redox characteristics of the polymer also including changes in the conductivity/resistivity of the polymer. Also the primary conducting polymer discussed in the paper is polypyrrole. In the first full paragraph of page 308, polypyrrole is used as the example of a current change associated with oxidation or reduction of the polymer backbone by an analyte. Polypyrrole is also used as the example of a conducting polymer used in an amperometric sensor in the second full paragraph of the solution chemical sensors section on page 308. Polypyrrole is again used as the example conducting polymer in the second full paragraph of the gas sensors section on page 310. In this paragraph the interaction (reaction) between the polymer and analytes nitrogen dioxide and hydrogen sulfide is characterized as oxidation or reduction. This is explained as causing a change which is “reflected in the increase in resistance that occurs in the presence of H_2S and the decrease in resistance observed with NO_2 .” This connection between the oxidation and/or reduction of the polymer and a change in the resistance of the material could not be more clearly stated. **Thus Barisci give a clear teaching that a change measurable by an electrochemical techniques is associated with a property change that is also measurable as a change in the resistance in the “sensing area”.** This clearly contradicts applicant’s position regarding the last paragraph of page 307 in Barisci as found in the second full paragraph of page 23 of the Appeal Brief. Barisci also give some indication that potential expected lowering of sensitivities in composite materials that included that conducting polymer was not a significant problem. The composites additionally provided improved reproducibility relative to the conducting polymer by itself. Thus Barisci also dispels expected disadvantages relative to composite materials and provides an expectation of improved properties for the composite relative to the polymer by itself.

Relative to the combination of references with Gibson as the primary reference examiner agrees that Gibson and the other applied references do not anticipate the claims. This is based on insufficient description of what constitutes a blend of the listed polymers and how it might differ from the copolymer that is found in the same sentence of page 13. However for the following reasons examiner submits that there is sufficient motivation as a basis for the respective combinations. First, as explained above, one of skill in the art would have looked to the

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electrochemical sensors for improvements in chemoresistive sensors based on the teachings of Barisci. Second, the references are not required to teach the invention (anticipate) or to be able to be bodily inserted into the primary reference to be appropriate for combination with the primary reference. With specific reference to the Casella reference applicant is directed to the sentence bridging the two columns of page 220. In that sentence Casella clearly teaches that about 12% of the deposited copper was able to penetrate the polymer matrix or was dispersed in the polymer matrix. While some of the copper may have been deposited on the polymer as applicant points out, Casella clearly teaches particles dispersed in the polymer matrix. Additionally heading 3.2 --"Electrocatalytic behavior of CU-PANI film electrodes"-- is clearly the type of reference that would be considered analogous from the disclosure of Barisci.

Relative to the Thackeray reference applicant is directed to the preparation of the platinized film as found in the paragraph in the right column of page 6675 beginning with "derivatization of microelectrodes". If one compares the derivatization procedure with that of the preparation of the copper dispersed electrodes of Casella (page 219, left column last paragraph), it becomes clear that the preparation methods are equivalent and therefore a portion of the platinum penetrates or is dispersed within the conductive polymer matrix. The Thackeray reference is also relevant to the instant claims as explained above relative to the use of an electrochemical sensor to modify a chemoresistive sensor.

Relative to the Yamato, Sakaguchi, Wampler and Li references, they are also relevant to the instant claims as explained above relative to the use of an electrochemical sensor to modify a chemoresistive sensor.

Relative to the Naarmann reference applicant is directed to instant table 2. In the organic conductors the instant specification lists charge transfer complexes of which the last listed is tetrathiofulvalene complexes. Examiner asserts that this is equivalent to the tetra:thia:fulvalene in the title of the English language abstract. For this reason Naarmann does contain an organic conductor as found in the Markush group of the claims. The Naarmann reference is also relevant to the instant claims as explained above relative to the use of an electrochemical sensor to modify a chemoresistive sensor.

Relative to the Breheret, Mifsud, Moy or Persaud references, they are not intended to teach modifying the polymer composition of Gibson, but are used relative to claims that require

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sensors of a type other than the sensor material in claim 98. Thus they have been separated and used for the claims that they are clearly relevant with. These reference clearly show the benefit of multiple types of sensors to distinguish the aromas/odors for which they are intended. They also show a need to heat the metal oxide semiconductor sensors to a temperature above room temperature. These references are also present for their teachings relative to the structure used to allow the sensors to contact the analyte containing gas.

The Stetter reference shows the interchangeability of carbon black and metal particles as components in a polymer sensor. Examiner cited this reference to include this aspect into the rejection.

Relative to the unexpected results, examiner points out that the unexpected results are relative to sensing compositions in which carbon black is placed in an insulating polymer. This is not commensurate in scope with the instantly applied references directed to conducting polymer sensing materials which teach the conducting polymer or the conducting polymer/compositionally different conducting material. For unexpected results to be relevant the comparison should be between the closest prior art and the claimed device. Examiner's position is that the closest prior art is the conducting polymer sensing material rather than the carbon black/insulating polymer composite sensing material.

7. The prior art made of record and not relied upon is considered pertinent to applicant's disclosure. The additionally cited art relates to composite materials and gas sensing structures.

8. The Sakaguchi and Naarmann references has been submitted for translation so that their teachings can more fully be considered relative to the instant claims. A copy of the translations will be sent with the next communication from the examiner or upon request from applicant after the translations are available.

Any inquiry concerning this communication or earlier communications from the examiner should be directed to Arlen Soderquist whose current telephone number is (571) 272-1265. The examiner's schedule is variable between the hours of about 6:30 AM to about 5:00 PM on Monday through Thursday and alternate Fridays.

A general phone number for the organization to which this application is assigned is (571) 272-1700. The fax phone number to file official papers for this application or proceeding is (703) 872-9306.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished

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January 24, 2005



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